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FLEXIBLE GLASS-PLASTIC LAMINATE

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ABSTRACT OF THE DISCLOSURE

A flexible glass-plastic laminate of a vapor impermeable glass sheet having a thickness of less than 0.01 inch bonded to a plastic layer having a percent elongation of at least 20 and a thickness of from 0.0005 to 0.02 inch formed from an epoxy resin or a polyurethane resin.

This invention relates to glass-plastic composites. More particularly, this invention relates to composites comprising thin glass substrates coated with epoxy or polyurethane resins.

A great deal of effort has been expended in attempting to develop a superior flexible insulating maerial. Properties sought in suitable material include high corona resistance, good flexibility and dimensional stability, and high mechanical strength.

At present, plastic materials, usually in the form of tapes, are widely used to insulate wires, cables and the like. Although satisfactory in some respects, plastic insulating tapes have certain defects which have prompted a search for substitutes. Among the drawbacks associated with plastic insulating tapes are low corona resistance, discoloration upon prolonged exposure to heat or light, and relatively high vapor permeability.

Another material which has been used as a flexible insulator is woven glass fabric. Although these fabrics have a high resistance to corona discharge, they are bulky and usually are vapor permeable. Thin glass tapes, although they have a high corona resistance, have not been widely used as flexible insulating materials because they are relatively breakable.

Accordingly, it is an object of this invention to provide a flexible, rugged and dimensionally stable glass-plastic composite article. A further object of the invention is to provide glass-plastic composites, especially glass-plastic insulating tapes, which have high corona discharge resistance and mechanical strength and which are vapor impermeable and resistant to discoloration upon exposure to heat or light.

In accordance with the invention, these and other objects are accomplished by coating a thin glass substrate with an epoxy or polyurethane resin. The plastic coating can be applied to the glass by brushing, roller-coating, dipping, spraying, or knife-coating. The preferred method of coating will vary with the type of plastic being applied and the speed of application required. The invention further contemplates a glass-plastic composite in which the plastic layer contains a coupling agent, thus forming a laminate which is highly resistant to peeling.

The invention will be more fully appreciated in the light of the following detailed description of the invention considered with reference to the accompanying drawing which illustrates certain preferred embodiments of the invention.

In the drawing:

FIGURE 1 is a perspective view of a composite glass-plastic sheet in accordance with the invention, and

FIGURE 2 is a perspective view of a roll of composite glass-plastic insulating tape in accordance with the invention.

The glass substrates which are used in the composite

articles of this invention are extremely thin and flexible. The glass sheet should be of a thickness less than 0.01 inch. Preferably, the glass substrate will be as thin as possible, with glass having a thickness of 0.0001 inch being a realistic lower limit. Due to the current technical problems of forming glass sheets 0.0001 inch thick, a preferred thickness for commercial production will be in the range of from 0.0005 inch to 0.01 inch. The glass may be in the form of thin relatively narrow strips or tapes or may take the form of sheets of larger size, depending upon the end use of the composite.

Referring to the drawing, by way of illustration, it will be seen in FIG. 1 that the composite or laminate **10** may comprise a thin sheet of glass **11** bonded to a layer **12** of epoxy or polyurethane resin. As shown in FIG. 2, the composite **20** again comprises a thin layer of glass **21** bonded to a layer **22** of epoxy or polyurethane resin. In this instance, the laminate is in the form of a relatively narrow elongated tape or strip which may be wound into a spool or reel **23**.

As shown in the drawings, the thin glass substrates **11** and **21** are preferably laminated or coated only on one surface with epoxy or polyurethane plastic layer **12** and **22** respectively. However, in certain instances, useful products may be obtained by laminating plastic layers to both surfaces of the thin glass substrate.

The plastic layer or coating of the composite is formed from an epoxy or polyurethane resin. As one function of the plastic layer is to increase the break resistance of the thin glass substrate, flexible epoxy or polyurethane resins having an elongation to the breaking point thereof of at least 20% are used. The thickness of the plastic layer is dependent in part on the glass thickness, with thinner plastic layers being used with thinner glasses. A practically useful range of plastic thickness is from about 0.0005 inch to 0.020 inch. The strength of the glass plastic composite is increased by increasing the flexibility and/or thickness of the plastic layer. For example, when a glass ribbon 0.0012 inch thick is coated with a layer of epoxy resin 0.0025 inch thick, the strength of the composite increases with an increase in the percent elongation of the plastic, as shown by Table I.

TABLE I

Stress at breakage, p.s.i.$\times 10^3$:	Percent elongation of epoxy
80	20
90	100
110	200
120	300

The ratio of glass to plastic thickness also affects the break resistance of the composite. For example, a 0.0012 inch thick glass sheet coated with a 0.006 inch thick layer of an epoxy resin having 125% elongation requires two and one-half times more force to penetrate with a sharp object, such as a nail, than does a similar piece of glass coated with a 0.002 inch thick epoxy layer.

Epoxy resins of sufficient flexibility to be useful in these composites are well known in the art and need not be described in detail here. These resins are generally formed by reacting epichlorohydrin with various polyglycols, such as glycerine. Commercially available resins include Epi-Rex 502, 5021, 5042 (Jones-Dabney) and Epon 812 and 872 (Shell Chemical Co.)

The epoxy resin employed does not have to be inherently flexible. Modifiers, such as organic polysulfides, can be added to non-flexible epoxy resins to render them sufficiently flexible for use, or to flexible epoxies to enhance their properties. An example of a suitable polysulfide modifier is Thiokol LP-3. In addition to or instead of employing these modifiers, a flexible curing agent can be